out the salient points to be considered when a physician is confronted by a pregnant woman with heart disease. To me, the most important section of the paper is the practical guide for determining the severity of the cardiac lesion and the subsequent treatment thereof.

The great majority of patients with heart murmurs can be grouped in Class 1, even though the murmurs may seem to indicate extensive damage. Actually, most of these patients are well compensated. This calls to mind one young primiparous patient who had had rheumatic heart disease with a resultant mitral regurgitation and mitral stenosis, a slight tachycardia, but otherwise well compensated. The heart-sounds on the right side sounded almost as loud as on the left. She went through an uneventful pregnancy and normal delivery.

It is after getting into the second class that the judgment of the attending physician becomes increasingly more taxed, and the necessity of having a competent cardiac specialist more urgent.

The general care of the mother, both before and after delivery, has been very adequately covered, but I will have to take exception to the essayist as to the type of delivery. With proper preparation and in competent hands, a cesarean section would seem to be less strain on a bad heart of a primipara than a normal delivery. Of course, if the patient has had previous deliveries, she could be allowed a test of labor and probably would have no undue trouble. She should be advised to definitely limit the number of pregnancies.

Individuals falling into Class 2B and Class 3 are, to all intents and purposes, to be treated similarly. If an early diagnosis of pregnancy is made, the patient should be therapeutically aborted; but if this is inadvisable because she is too far advanced in her pregnancy, a hysterotomy with resection of the tubes is indicated. Whether she should be allowed to go to term would depend entirely upon her reaction to adequate conservative treatment. In most cases the added strain of resecting the tubes following cesarean section is not sufficient to warrant requiring the patient to submit to a later operation. An illustrative case of Class 2B is that of a 35-year-old woman, first seen when five months pregnant. At twelve years of age she acquired typhoid fever, resulting in serious cardiac damage. She had had two miscarriages at two and five months, and two normal deliveries. Against the advice of her former physician, she yielded to her second husband's desire to have a child of his own. Toward the middle of her fifth month, she developed what was at first diagnosed as influenza and later diagnosed as left pyelitis. After cystoscopy showed both kidneys to be normal, a blood culture taken revealed a streptococcus vividous septicemia. She was given the usual supportive treatment, transfusions and sorocin, to no avail. About one month after the onset, she miscarried a two-pound fetus and a few days later died.

❦

BERNARD J. HANLEY, M. D. (1930 Wilshire Boulevard, Los Angeles).—We have used the classification of the American Heart Association for the past several years in the Los Angeles Maternity Service. The diagnosis and classifications were made in conjunction with our attending cardiologist. Our feeling has been that the results are better and the patients can be told what their outlook is, both for this and for future pregnancies.

In a recent review of our cases we found a surprisingly low percentage with organic heart disease. This is perhaps due to the small amount of rheumatic fever seen in Southern California.

I would like to add that a patient in labor with organic heart disease should have analgesia pushed to the limit of safety.

❦

E. A. ROYSTON, M. D. (8627 South Vermont Avenue, Los Angeles).—When the woman suffering from heart disease finds her problems complicated by expectant motherhood, and tells her story to her attending physician, she immediately places on him a responsibility much graver than the ordinary. He must detail to her the dangers which lie ahead, not only during the pregnancy and delivery, but also during the ten to twenty years when the child will need the care and guidance of its mother.

The greatest desire of the average woman, whether she be the savage in the jungle or the queen upon the throne, is that she be allowed, by a kindly providence, to have at least one child. This natural instinct, however, must not be allowed to overinfluence the scientific judgment of her attending physician.

The matter of carrying a pregnancy to a successful termination is very much a personal one, not only to the expectant mother, but also to the attending physician. In these cases, where there is serious cardiac complication, there must be complete coöperation between the patient and the physician, or the work should not be undertaken.

Doctor De Puy has written a careful and beautiful paper, and has given us much food for thought. His Case No. 3 was truly tragic and pathetic; but after all, had not the woman reached her life's goal and ambition? There is still the human element that is hard to overcome. One of the greatest joys of my practice was to guide a serious cardiac case safely through pregnancy and delivery, and yet, after five years, to be able to report, "Mother and son still both doing well." The author's statistics and his method outlined for the care of the expectant mother complicated by cardiac disease are worthy of much study and attention.

THE LURE OF MEDICAL HISTORY†

MR. JOHN HUNTER ON GENERATION*‡

By ARTHUR WILLIAM MEYER, M.D.
Stanford University

IV**

HUNTER'S CLASSIFICATION OF MONSTERS

IN classifying monsters, Hunter further said: "Of monsters there are two principal classes, viz., Duplicity of Parts and Deficiency of Parts; and there is a third class, viz., Bad Formation. The first is, by much, the most frequent." (*Ibid.*, p. 248.)

"I should imagine that monsters were formed monsters at the very first formation for this reason, that all supernumerary parts are joined to their similar parts; for example, a head to a head, &c.

"But monsters, in some cases, may be said to be accidental, as the horn growing out of the forehead of the ox or cow.

"Is not the forked end of the fang of a tooth a species of monstrosity? and does not the manner of its formation show the nature of monsters, viz., two fangs being formed from a preternatural process taking place?

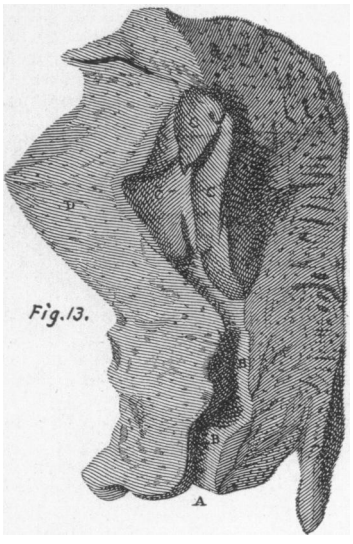
"We often find in the human body an appendix or process passing out from the small gut; and I

† A Twenty-Five Years Ago column, made up of excerpts from the official journal of the California Medical Association of twenty-five years ago, is printed in each issue of CALIFORNIA AND WESTERN MEDICINE. The column is one of the regular features of the Miscellany department, and its page number will be found on the front cover.

* Because John Hunter occupies so large a place in the development of surgery, it is commonly but erroneously assumed that he had the title of Doctor of Medicine.

‡ From the department of anatomy, Stanford University Medical School, Stanford University.

** Part I of this paper was printed in the August issue of CALIFORNIA AND WESTERN MEDICINE, page 145; Part II, in the September issue, page 222; Part III, in the October issue, page 283. The present paper concludes the series.



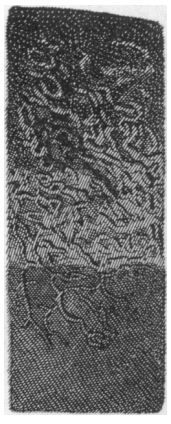


Fig. 14

Figs. 13 and 14.—"This plate represents a section of the human uterus in the first month after impregnation. The uterus itself is a little enlarged in size, and thickened in its substance; its cavity, everywhere lined with a coagulum of blood, having a smooth internal surface, but adhering firmly to the uterus.

"The arteries are injected to show that it is uncommonly vascular, and vessels are found to be injected in different parts of the coagulum.

"The object of this plate is to show the readiness with which vessels are formed in coagulated blood, when attached to a living surface, and its vascularity being to answer useful purposes in the machine, of which this is a remarkable instance, as it is to form the outer membrane of the foetus, or the connecting medium between it and the uterus.

Fig. 13.—"A longitudinal section of the uterus, in which the cavity is exposed.

"*A*, the os tincae projecting into the vagina, of which there is a small portion, to show the length to which the os tincae projects. *BB*, the cervix uteri. *CCC*, the coagulated blood, smooth upon its internal surface, although extremely irregular. *DD*, the cut surface of the substance of the uterus, which has so intimate a connexion with the coagulum that the one appears to be continued into the other. The laminated appearance is produced by the section of enlarged veins in a collapsed state, which are extremely numerous.

Fig. 14 "is a thin slice of the substance of the uterus and the coagulum adhering to it, dried, and viewed in a microscope, to show the vascularity of the uterus, whose vessels are distinctly seen, continued into the coagulum, and passing about halfway through its substance." (Palmer, p. 10.)

believe always from the ileum. In the year 1763, I found one of these in a body situated about one foot and a half from the cæcum. In the same winter I found another nearly three feet from the cæcum." (*Ibid., i,* p. 251.) Since Hunter did not know the significance of Meckel's diverticulum, it is not surprising that he misinterpreted it.

A clearer expression of his idea of environment as a factor in the production of monsters is contained in the following quotations: "A part having the power within itself of elongation, will have the power of varying in that elongation according to circumstances; therefore a head not yet formed, but only having a disposition to form, may by some accident be disposed to be formed into two heads, and the same with every part of the body." (*Ibid., i,* p. 244.) . . . "Lizards therefore have two or more chances or periods in which they can or may form a monstrous tail; for they have the first formation common to all animals, which should be called the first growth; and they have the accidental causes of a new or second growth, all which are due exactly to the same principle, viz., a new formation of a part. This, however, arises from an obstruction to the formation of one tail only; for, if the part which is to form the tail be slit but a very little into two points, these will form each a tail; so that an obstruction to the natural disposition becomes the cause of another taking place. I have seen this disposition so strong in the tail of the lizard, that a wound on the side of the tail has given the disposition for a young supernumerary tail to grow out of the wound." (*Ibid., i,* p. 245.)

In view of the notable contributions of Bartelmez on menstrual changes, it is of great interest that Hunter stated that in a young woman who died at St. George's Hospital during menstruation, the cavity of the injected uterus contained extravasated material and that ". . . on the inner surface there were dots of injection, as if swelled out at the end or opening of a vessel, just ready to drop off." (Essays and Observations, *i,* p. 193.)

ON THE STRUCTURE OF THE PLACENTA AND IMPLANTATION

In regard to the structure of the placenta and implantation (see Figure 13), Hunter wrote:

"The placenta seems to be principally composed of the ramifications of the vessels of the embryo, and may have been originally formed in consequence of those next to the uterus laying hold by a species of animal attraction of the coagulable lymph which lines the uterus. It might take place in a manner resembling what happens when the root of a plant spreads on the surface of moist bodies, with this difference, that in the present instance the vessels form the substance through which they ramify, as in the case of granulations.

"At the time, or perhaps before, the female seed enters the uterus, coagulable lymph, from the blood of the mother, is thrown out everywhere on its inner surface, either from the stimulus of impregnation taking place in the ovarium, or in consequence of the seed being expelled from it. But I think the first the most probable supposition; for we find in extra-uterine cases that the decidua is formed in the uterus, although the ovum never enters it, which is a proof that it is produced by the stimulus of impregnation in the ovarium, and that it is prior to the entrance of the ovum into the uterus. When it has entered the uterus it attaches itself to that coagulable lymph, by which, being covered and immediately surrounded,† there is formed a soft pulpy membrance, the decidua, which I believe is peculiar to the human species and to monkeys, I never having found it in any other animal. That part which covers the seed or fœtus, where it is not immediately attached to the uterus, and likewise forms a membrane, was discovered by Dr. Hunter, and is by him called decidua reflexa.* The whole of this coagulable lymph continues to be a living

"† This is somewhat similar to another operation in the animal œconomy. If an extraneous living part is introduced into any cavity, it will be immediately inclosed with coagulable lymph. Thus we find worms inclosed, and hydatids, that have been detached, afterwards inclosed; but in those cases this is a consequence of the pressure of the extraneous body, whereas in the uterus it is preparatory."—J. H.

"* The placenta is certainly a fœtal part, and is formed on the inside of the spongy chorion, or decidua. How far the decidua reflexa is a uterine part I do not yet know; if it is, then the ovum must be placed in a doubling of the coagulum, which forms the decidua; but if the ovum is attached to the inside of the decidua, then the decidua reflexa is belonging to the fœtus."—J. H.

part for the time; the vessels of the uterus ramify upon it; and where the vessels of the fœtus form the placenta there the vessels of the uterus, after passing through the decidua, open into the cellular substance of the placenta, as before described. As this membrane lines the uterus and covers the seed, it is stretched out, and becomes thinner and thinner, as the uterus is distended by the fœtus growing larger, especially that part of it, called decidua reflexa, which covers the foetus; as there it cannot possibly acquire any new matter, except we could suppose that the fœtus assisted in the formation of it. This membrane is most distinct where it covers the chorion; for where it covers the placenta it is blended with coagula in the great veins that pass obliquely through it, more especially all round the edge, where innumerable large veins come out; but the chorion and decidua can be easily distinguished from one another, the decidua being less elastic." (Animal Œconomy, pp. 97-98.)

"The arteries which are not immediately employed in conveying nourishment to the uterus go on towards the placenta, and, proceeding obliquely between it and the uterus, pass through the decidua without ramifying; just before they enter the placenta, after making two or three close spiral turns upon themselves, they open at once into its spongy substance without any diminution of size, and without passing beyond the surface, as above described. The intention of these spiral turns would appear to be that of diminishing the force of the circulation in the vessels as they approach the spongy substance of the placenta, and is a mechanism calculated to lessen the quick motion of the blood in a part where a quick motion was not required. These curling arteries at this termination are in general about half the size of a crow's quill, and sometimes larger.

"The veins of the uterus appropriated to bring back the blood from the placenta commence from this spongy substance by such wide beginnings as are more than equal to the size of the veins themselves. These veins pass obliquely through the decidua to the uterus, enter its substance obliquely, and immediately communicate with the proper veins of the uterus. The area of these veins bears no proportion to their circumference, the veins being very much flattened.

"This structure of parts points out at once the nature of the blood's motion in the placenta; but as this is a fact but lately ascertained, a just idea may perhaps be conveyed by saying that it is similar, as far as we yet know, to the blood's motion through the cavernous substance of the penis.

"The blood detached from the common circulation of the mother, moves through the placenta of the fœtus; and is then returned back into the course of the circulation of the mother, to pass on to the heart.

"This structure of the placenta, and its communication with the uterus, leads us a step further in our knowledge of the connexion between the mother and the fœtus. The blood of the mother must pass freely into the substance of the placenta, and the placenta most probably will be constantly filled; the turgidity of which will assist to squeeze the blood into the mouths of the veins of the uterus, that it may again pass into the common circulation of the mother; and as the interstices of the placenta are of much greater extent than the arteries which convey the blood, the motion of the blood in that part must be so much diminished as almost to approach to stagnation. So far and no further does the mother appear to be concerned in this connexion.

"The fœtus has a communication with the placenta of another kind. The arteries from the fœtus pass out to a considerable length, under the name of the umbilical arteries, and when they arrive at the placenta ramify upon its surface, sending into its substance branches which pass through it, and divide into smaller and smaller, till at last they terminate in veins; these, uniting, become larger and larger, and end in one, which at last communicates with the proper circulation of the fœtus.

"This course of vessels, and the blood's motion in them, is similar to the course of the vessels and the motion of the blood in other parts of the body." (Animal Œconomy, pp. 99-100.)

TESTICULAR DESCENT

Hunter's study of testicular descent and of the gubernaculum are too well known to require much comment, though he thought that of the testicles ". . . the lowest is the most vigorous"; and he was correct in saying that "When one or both testicles remain through life in the belly, I believe that they are exceedingly imperfect, and probably incapable of performing their natural functions, and that this imperfection prevents the disposition for descent from taking place. That they are more defective than even those which are late in passing to the scrotum, is to be inferred from what is very evident in quadrupeds, the testicle that has reached the scrotum being in them considerably larger than the one which remains in the abdomen. It is probable that this peculiarity is a step towards the hermaphrodite, the testicle being seldom well formed. I have only seen one case in the human subject where both testicles continued in the abdomen; this proved an exception to the above observation, since we are led to conclude that they were perfectly formed, as the persons had all the powers and passions of a man." (Animal Œconomy, p. 56.) Hunter no doubt was right in saying that this man had all the "passions," but he probably did not have all the "powers" of a man; but Owen was badly mistaken when, in comment on these words of Hunter, he wrote: "It seems remarkable, that with this experience Mr. Hunter should have formed, from inconclusive analogy, and promulgated an opinion tending to occasion so much unhappiness as that which attributes exceeding imperfection, and probable incapacity of performing their natural functions, to testes which in the human subject are retained within the abdomen. That there is nothing in such a situation which necessarily tends to impair their efficiency, is evident, from the number of animals in which they

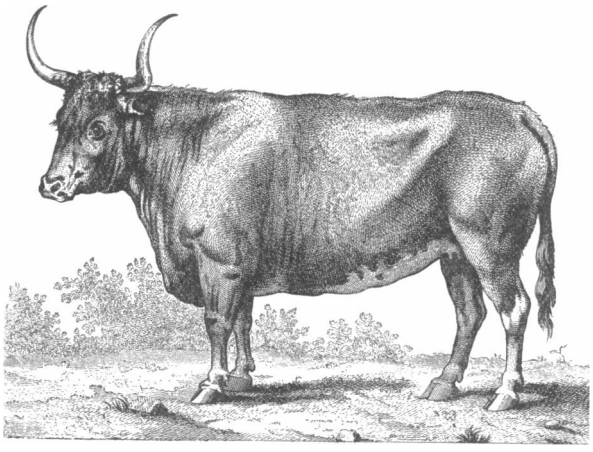


Fig. 15

Fig. 15.—A reproduction of an illustration of Mr. Wright's free-martin, from Hunter's paper on that subject, taken from a drawing of the living animal by Mr. Gilpin. "It shows the external form of that animal, which is neither like the bull nor cow; but resembling the ox or spayed heifer." (Palmer, p. 18.)

constantly form part of the abdominal viscera. And in those in which the testes naturally pass into a scrotum, their continuance in the abdomen, according to our author's own observation, is accompanied only with a difference of size or shape; now we may readily suppose that this may influence the quantity, but not necessarily the quality of the secretion." (*Ibid.*) Unfortunately for Sir Richard, it has been known for some years that Hunter was right, for although individuals with undescended testes have potentia coeundi, they do not possess potentia generandi.

It is not generally known that Hunter's attention was called to the free-martin by his loyal pupil and faithful friend, Edward Jenner. (See Figure 15.) In a letter to the Reverend Doctor Worthington, written on April 5, 1810, Jenner said: ". . . Pray do not part with your free-martin; it will be a beautiful animal, and docile and useful in your fields as an ox. I have dissected many; but why this mingling of the sexes should arise under such circumstances, eludes all my guesses. Some of the tricks going forward among the inhabitants of the uterus I have long since pretty well made out; but this is too much for me. I was the first who made the fact known (some thirty years ago) to Mr. Hunter. He soon went to work upon the subject and the result was an excellent paper in the Philosophical Transactions. It was republished in his work on Animal Œconomy."

That Hunter was aware of the fact that the free-martin had long been known is indicated by the following footnote from his article: "The Romans called the bull, taurus; they, however, talked of taurae in the feminine gender. And Stephen observes, that it was thought the Romans meant by taurae, barren cows, and called them by this name because they did not conceive. He also quotes a passage from Columella, lib. vi. cap. 22, 'and like the taurae, which occupy the place of fertile cows, should be rejected, or sent away.' He likewise quotes Varro, De Re Rustica, lib. ii. cap. 5, 'The cow which is barren is called taura.' From which we may reasonably conjecture that the Romans had not the idea of the circumstances of their production" (Animal Œconomy, p. 76); but neither did Hunter have this idea. That was first conceived, and the underlying anatomy revealed, by Keller and Tandler in 1916 in Europe, and shortly thereafter also by Lillie in this country. What Hunter meant was that the Romans were not aware of the anatomical states which occur in the reproductive organs of free-martins. It was this that he ascertained by careful intravitam and postmortem studies. Hunter realized that "Hermaphrodites are to be met with in sheep; but, from the account given of them, I should suppose that they are not free-martins. . . . Of all the specimens which I have dissected, I shall only give the descriptions of the three which point out most distinctly the complete free-martin with the gradations towards the male and female." (*Ibid.*, p. 77.) ". . . I shall retain the term, free-martin, to distinguish the hermaphrodite produced in this way from those which resemble the hermaphrodite of other animals; for I know that in black cattle such a deviation may be produced without the circumstance of twins: and even where there are twins, the one male the other a female, they may both have the organs of generation perfectly formed. But when I speak of those which are not twins, I shall call them hermaphrodites: the only circumstance worth our notice being a singularity in the mode of production of the free-martin, and its being, as far as I yet know, peculiar to black cattle." (*Ibid.*, p. 75.)

Although John Hunter's many years of study of the developing "chick of the goose" did not contribute much in words besides a sketch, they did give us many fine crayon drawings which far surpass those of earlier days. Since they were left almost wholly without legends, it is evident that this, like the text for the gravid uterus by William, was an unfinished task, but it may be said in extenuation that Hunter was stricken suddenly by death. He was such a prodigious worker and since he maintained an interest in the subject for almost forty years, it is reasonable to conclude that he would have finished the task had more time been granted him. Even so, John Hunter's claim to a place in the history of embryology far outweighs that of his brother. John deserves remembrance especially because he was the first to observe that the heart beats before the blood is red and mentioned the formation of blood islands outside of the embryo. He also was of the opinion that the allantois acted as a lung, observed oögenesis in the goose and hen and searched for the mammalian ovum. He was the first to determine the effect of the removal of one ovary on litter size. He further observed that the implanted mammalian ovum has a local effect upon uterine growth and rediscovered the independence of the fetal and maternal circulations. He made observations on comparative placentation, described the uteroplacental circulation more accurately than it had been described before, and was the first to observe that desquamation of the endometrium is accompanied by the rupture of

arterioles. He described the descent of the testis and rightly concluded that the seminal vesicles are not primarily reservoirs for spermatozoa. He also distinguished carefully between the decidua and the placenta, recognized the rôle of both heredity and environment in the production of monsters and formulated a recapitulation idea. Although he said there was some evidence in favor of preformation, metamorphosis and epigenesis, his own observations, as well as his own words, were mainly in support of the latter.

He kept a flock of geese for fifteen years, hatching two broods per goose per summer, had many dissections made of the embryos and fetuses, and employed competent artists during a period of almost forty years for the production of a larger and better series of drawings on development than any existing before. He maintained his interest up to the time of his death and deserves special remembrance not only for his spirit, but also for his accomplishments. It is true that John Hunter lacked faith in the microscope and believed that egg-white, blood and chyle were alive and that the absorbent vessels possess consciousness and are present in the unhatched egg. He apparently failed to comment on the amazing discovery of spermatozoa made fifty-one years before his birth, and was unacquainted with Wolff's work. But he was an assiduous worker, an outstanding experimenter, and gave advice of foremost importance when he said, "Why think? Why not try the experiment?" He maintained his curiosity through his entire lifetime, and it was very characteristic of him to ask in a letter written to his faithful pupil Jenner, "Where the devil do eels go in winter?" Surely to such a man much may be forgiven.

THE CONTROVERSY BETWEEN JOHN AND WILLIAM HUNTER

It is difficult to contemplate the splendid royal folio on the gravid uterus by William without sympathy for John. It does not seem possible that the latter could have said what he did, and taken the steps he did more than a generation afterward if he himself had not made the discovery he claimed, regarding the uteroplacental circulation, and surely nothing could be more evasive than the rejoinder of William. John was very specific and said that William received his conclusion with raillery at the time. In referring to this regrettable controversy, in a footnote in CALIFORNIA AND WESTERN MEDICINE of June, 1932, I expressed my sympathy for John somewhat ambiguously, so that some readers inferred that I shared John's mistaken attitude toward the classics. That is not the case, and it is interesting that Butler (1910) thought that "Doubtless . . . linguistic studies would have served to correct in him what was perhaps a natural defect. . . ."

It is quite possible that any friction that may have previously existed between these famous Scotchmen was intensified by the prior election—though by only two months—of John to the Royal Society in 1767. This happened at a time when, as Ottley said, John had made no independent contribution to that Society, while William, who was ten years older and had been his brother's preceptor, had made one. He had also been in London seven years longer, had been elected to the Corporation of Surgeons in 1747, and enjoyed a well-earned reputation. William also had received his degree of Doctor of Medicine in 1750, and had been made physician-extraordinary to the Queen in 1764. Under such circumstances the previous election of John, who never had obtained a degree of any kind, might well rankle. A further cause of rivalry, if not of irritation, may have been William's request of 1765, to the prime minister, for a grant of ground in London upon which to establish ". . . a museum . . . for the improvement of anatomy, surgery, and physics." Although John could not have collected many specimens by this time, it is known that he had similar aims and aspirations, and that he also had begun the collection of specimens for a museum.

Another source of irritation may have been John's decision to marry. Since he was not married until his forty-third year, the opposition of his bachelor brother, however justly grounded, probably did not promote better relations between them, especially since there was no just ground for thinking that so capable a man as John could not support a family, or that so arduous a worker as he would relax his efforts unduly thereafter. Had John been less competent and industrious, or had he been a mere youth, there might have been more justification for the opposition of William, and had a Damon and Pythias relation existed between them, one could excuse William for regretting the separation that marriage implied. One cannot help surmising that William must have felt compunctions regarding the matter as the career of John and his domestic life unfolded, and as Mrs. Hunter emerged as an unusually accomplished woman, immortalized in both song and verse. How very kind Fate was to her and to John in view of his self-inoculation with the venereal diseases, only present-day medicine knows.

IN CONCLUSION

Since what is known of his work abundantly assures John's survival among the immortals, it is fortunate that he could not divine the use made of his voluminous notes and their ultimate strange fate at the hands of his knighted brother-in-law, Sir Everard Home. What a happy contrast to him was William Clift, who came to Hunter as a mere lad, only twenty months before Hunter's death, but who nevertheless guarded his notes and collection with singular fidelity and zeal! Surely, his devotion also speaks eloquently for the character of John, to whom the title of Doctor of Medicine, no more than any other, could have brought no additional honor. Untutored, unlettered, unpolished and untitled, was simple Mr. John Hunter, but great and immortal nevertheless.

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CLINICAL NOTES AND CASE REPORTS

IMPROVEMENT OF THE BELL STETHOSCOPE

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MANY new instruments are described and urged upon the general practitioner as well as the specialist. Some of these are so complicated that special training in their use is necessary for their replacing of present available equipment. A few of these instruments are made differently, so entire replacement will be needful, affording remunerative reward to the inventor and manufacturer. However, outside of clothing and personal equipment, with special reference to broken-in shoes, spectacles and false teeth, there is probably nothing so treasured and well liked as one's stethoscope. This is a fact, doubtless, most appreciated by the cardiologist, chest specialist, and obstetrician. Sir Wilfred Grenfeld has carried one stethoscope for over a score of years. Therefore, we suggest a modification instead of a replacement of your instrument.

Muscles vibrate at a slow rate, and by means of sympathetic resonance a musical tone is elicited from certain tested muscles. Piper, using the string galvanometer, found the electrical alternations corresponding to the voluntary muscular contraction of the flexor muscles of the fingers to be fifty per second, the muscles of the forearm vibrating at about the same rate. Ordinary city electrical current alternates at the rate of fifty to sixty times per second, which is quite noticeable in electrical devices such as heaters, toasters, etc., which act as resonators. These muscle sounds are transmitted from the fingers to the stethoscope, unless a form of insulation is used.

Added to the above vibrations is the tremor which befalls the attendant who personally watches his patient through long continuous hours. Therefore, a stethoscope to be most efficient must (*a*) be comfortable to the doctor, (*b*) be comfortable to the patient, and (*c*) transmit maximum sound with minimum static.

The comfort of the doctor concerns itself with the binaural end of the stethoscope, the tips of which should be of the right size and at the proper angle to correspond with the external canal of the individual using them. And they are more comfortable if made of a poor heat conductor. The tips must be applied to the ears with sufficient tension to keep out room noises, little tension being most comfortable. The larger the caliber of the hole in the metal, and the heavier the rubber tubing, the more tense has to be the spring to hold the tips applied to the ears.

The comfort of the patient is best served by a poor heat conductor at the point of contact of the chest piece with the patient.

The transmission of the sound, although considered last, is not the least important. The rubber tubing should be stiff enough to resist too easy bending, which in itself introduces noise as well